for guidance in the task which in his future career he may have to face, of collecting workmen in inaccessible districts, of housing them, and of looking after them generally.

The work contains 281 illustrations, some being drawings to scale and others reproductions of photographs, showing in a striking manner the operations of mining and quarrying. All are excellent, and, like the letterpress, are exceptionally well printed. A very full and accurate index greatly adds to the value of the book.

B. H. B.

SOME BOOKS ON QUATERNIONS.

Etude sur les Quantités mathématiques. Grandeurs dirigées, Quaternions. By Prof. Claro Cornelio Dassen, D. es Sc. Pp. vi+133. (Paris: A. Hermann, 1903.) Price 5 francs.

Introduction to Quaternions. By the late Profs. Philip Kelland, F.R.S., and P. G. Tait. Prepared by C. G. Knott, D.Sc. Pp. vii+208. (London: Macmillan and Co., Ltd., 1904.) Price 7*s.* 6*d.*

Bibliography of Quaternions and Allied Systems of Mathematics. Drawn up for the International Association for Promoting the Study of Quaternions, &c. By Alexander Macfarlane, D.Sc., LL.D., F.R.S.E., General Secretary of the Association. Pp. 86. (Dublin: University Press, 1904.)

IT may perhaps be rather an exaggerated statement, but it is none the less to a great extent true, that mathematicians tend to divide themselves into two classes, quaternionists and non-quaternionists, and that these two classes frequently become involved in polemical controversies. But at the present time the notion of vector quantities is of frequent occurrence in physics, and it is important that everyone should have an opportunity of understanding the laws and nature of vector operations. It is not unfrequently stated that forces are vectors, because they are directed quantities, and *therefore* they are compounded by the parallelogram law. But the moment of inertia of a body about a line is also a directed quantity in the sense that its magnitude depends on the direction of the line, although moments of inertia, as every mathematician knows, are *not* compounded by the parallelogram law. Clearly dogmatic statements about vectors are dangerous for teaching purposes.

Dr. Dassen's book deals with a much wider field than the study of quaternions proper. The first part treats of "the concept of quantity," *i.e.* the fundamental laws of algebra. The second part is divided into three chapters, which treat of directed quantities in space of one, two and three dimensions respectively, so that it is only in this last chapter that the particular system of algebra associated with the name of Sir W. R. Hamilton is discussed.

Prof. Knott's edition of Kelland and Tait's book is a typical English text-book of a kind such as writers of other nationalities rarely produce. By this we imply that it is full of worked illustrative examples, and at the end of each chapter is a copious collection of examples for exercise. The first five chapters, extending up to p. 89, would form an excellent course for a student whose time is short.

The chapter on dynamical applications is an important innovation which might well be extended in the interest of science students by the addition of more elementary examples. Chapter vi., dealing as it does with "cones and their sections," possesses little interest for the modern student. It would have been more useful thirty years ago, when it was the fashion not to teach the calculus until the student had learnt by heart a series of propositions for the parabola, a second series for the ellipse, and a third series (scarcely ever properly understood) for the hyperbola. Nowadays more suitable illustrations may be obtained from physical problems without wasting time over these elaborate discussions about conics. On the other hand, chapter vii., dealing with central *surfaces* of the second order, is less detailed in its treatment, and consequently likely to be more helpful.

Dr. Macfarlane is to be congratulated on the very complete list of papers which he has succeeded in drawing up for the association of which he is secretary. These papers, we notice, cover different systems of multiple algebras, discussions on the geometric representation of complex magnitude, and nearly every book, pamphlet or paper on mathematics or physics in which quaternions or allied systems of mathematics play any part whatever, such, for example, as Clerk Maxwell's "Matter and Motion" or Minchin's "Statics." The only improvement that can be suggested is a classification of the papers by which those merely containing references to quaternions should be separated from those which treat of a substantial portion of the general theory of algebras of vector quantities.

OUR BOOK SHELF.

A Manual of Zoology. By Richard Hertwig. Translated and edited by J. S. Kingsley. Pp. xi+704. (London: G. Bell and Sons, 1903.) Price 12*s.* 6*d.* net.

THE English student of zoology has now the choice of a large number of excellent text-books, varying in style, in thoroughness, in wealth of illustration, but sufficient for the purposes of his education up to the time when his more advanced studies require him to turn his attention to the writings of foreign authors in their original language. To add to the list, the translation of a foreign text-book requires some special justification. It must provide something, some special treatment of a subject or some philosophical speculation which has not been provided by those who, with a knowledge of the needs of our own students, have written text-books for their guidance. The great reputation of Prof. Hertwig would lead us to expect a text-book from his pen that would justify its translation into the language of any country where zoology is seriously studied, and in some respects we are not disappointed.

The book opens with a definition of general terms and a short history of the development of the science from the time of Aristotle to the present day, which are admirably concise and clear. The pages dealing with general morphology and physiology are also decidedly excellent, better, perhaps, than are the corresponding parts of any other modern text-book. In the portion dealing with special zoology, however,

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there are many features which detract from its general merits. We might point out, for example, that the description given of the important group Protracheata is insufficient, and the statement that the animals included in it are viviparous is erroneous. The classification of the Pelecypoda adopted in the text is old-fashioned and by no means the best.

The statement on p. 206 that in Ciliata there is *a* micronucleus is misleading. It should be one or more micronuclei. These and many other general statements are unsatisfactory. The book, moreover, is disfigured by numerous misprints. Such a misprint as Afrida (p. 644) may not be of much consequence, but the misprints in the names of animals, such as Mylilidæ (p. 367), Chelefer (p. 450), Machrocheiroptera (p. 638), Strongylocentratus (p. 345), Saxicara (p. 367), and a great many others cannot but mislead the elementary student of zoology.

A Guide to the Antiquities of the Bronze Age in the Department of British and Mediaeval Antiquities, British Museum. Pp. xii + 159; 148 figures, 10 plates. (London: British Museum, 1904.) Price 1s.

THE members of the staff of the British Museum who are responsible for the "Guide to the Antiquities of the Bronze Age," which has just been published, are to be congratulated on having provided the public with a most excellent little manual which is not merely a guide to the collections in our National Museum, but is at the same time a convenient text-book on the Bronze age. There had long been a lack of authoritative handbooks on archæology in English, and in this respect we were at a disadvantage compared with certain other countries in Europe. Thanks to the energy and knowledge of Mr. C. H. Read and his colleagues and to the liberality of the trustees, we are now provided with two well written, precise, and copiously illustrated shilling books which supply this deficiency for the Stone and Bronze ages, and we are glad to note that a volume on the Iron age is in course of preparation.

In the closely packed twenty-six pages of the introduction we have a succinct account of the evidence for a Bronze age and its relative chronology; the existence of an antecedent Copper age is discussed, and it is admitted that some countries do possess a distinct Copper age. The author leans to the view that bronze was first discovered in China in the fifth millennium B.C. The Aryans are treated to a brief discussion, and the position is taken "that the Aryan language was forced upon the aboriginal inhabitants of Europe towards the end of the Neolithic period by a stalwart race with short skulls and fair hair, who radiated from some point in south-east Europe . . . the new comers are sometimes known as the Alpine race."

The bulk of the little book is taken up not with a mere catalogue of objects, but with an instructive guide to the objects in the collection, and for the further elucidation of the culture of the Bronze age descriptions and illustrations are given of hut-circles, brochs, and a barrow. A considerable amount of space is taken up with objects from various countries on the Continent, and by this means the finds in our own islands can be placed in their relative position in the cultural history of Europe. The numerous illustrations in this book are carefully chosen and well executed, and the book can be highly recommended to curators, students, and the general public.

The Care of Animals. By N. S. Mayo, M.S., D.V.S. (Rural Science Series). Pp. xvi + 459. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 5*s.* net.

THE agricultural reader who possesses Prof. Jordan's admirable text-book "The Feeding of Animals" will welcome this addition to the "animals" section of the Rural Science Series. The writer, Dr. N. S. Mayo, professor of veterinary science in the Kansas State College, indicates his standpoint in the following two sentences taken from the preface. "The day of the 'horse-doctor' book is passing. Prevention, sanitation, careful handling are more important than mere medication."

The first section of the volume, treating of the general care of animals, is a little disappointing. There is much common sense, but there is also a suspicion of padding. The illustrations of farm live-stock in chapter i. have no particular point, and one feels that a dozen pages of illustration and letterpress transferred from the first three chapters to the chapter on veterinary obstetrics would have been an advantage. When the writer comes to his own subject, the care of sick animals, there is a great improvement, and 400 pages are filled with just the kind of information that the stock-owner wishes to have. The chapters on the indications of disease and the nursing of sick animals are excellent. The descriptions of ailments, though quite free from medical terms, are pointed and so clear that even in the absence of professional assistance the farmer is likely to be able to recognise many of the diseases. The advice given is plain but guarded. The writer does not forget that there are medicines which may do harm, and he has given special prominence to the use of simple remedies; he urges the owner of valuable stock to take no risks, and when in doubt to consult a skilled veterinarian. For those unable to do this there is a short chapter on common drugs, doses and recipes. The book is likely to be popular in the British colonies, and its usefulness for the colonist would be increased if the sections on drugs and recipes were extended. In its present form, however, this addition to our agricultural text-books deserves popularity. To the stock-owner whose province it is to "nurse" rather than to "treat" the sick animal Prof. Mayo's volume will be most useful, and should be most welcome.

A Text-book of Ceramic Calculations, with Examples. By W. Jackson, A.R.C.S. Pp. xviii + 67. (London: Longmans, Green and Co., 1904.) Price 3*s.* 6*d.* net.

THIS little book is designed to supply students in classes in pottery and porcelain manufacture with a collection of problems and examples to illustrate the application of mathematical and chemical methods to the solution of the problems with which the potter is constantly confronted in his work. The preliminary lists of chemical substances—with their formulæ, atomic or molecular weights, and specific gravities—and of minerals important from the potter's point of view should prove useful. The heading on pp. 12–14, "List of Elements," is unfortunate, seeing that the substances tabulated are mostly compounds. More exercises for the student to work out might have been supplied with advantage, for instance, to chapter ix. one problem only seems to be given.

Botany Rambles. Part i. In the Spring. Pp. iv + 120. (London: Horace Marshall and Son, 1904.) Price 10*d.*

THE anonymous writer of this book for children gives the following excellent advice to the youngster beginning to read the little volume: "If you have not time to read this little book and go out as well, then don't read it, but go out instead." The information provided is given in clear, simple language, and is of a kind that a sympathetic adult taking a child for a ramble would strive to make the young botanist find out for himself. The photographs of trees in the book are very good.

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